NOTES ON CAPTIVE RABBIT BANDICOOTS (MACROTIS LAGOTIS)

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INTRODUCTION

Five species of bandicoots are known from arid areas of Australia, and all have declined greatly in numbers during this century (Wood Jones, 1924; Finlayson, 1935, 1961). Of these, the rabbit bandicoot *(Macrotis lagotis)* still retains a tenuous hold in the Northern Territory, adjacent areas of Western Australia and south-western Queensland (Smyth and Philpott, 1968; Watts, 1969). It is possible that small numbers may survive in northern South Australia. The opportunity still exists to study the biology of this species in comparison with that of the bandicoots of wetter areas.

Studies have been made on several species of bandicoots which inhabit coastal areas. Stodart (1966) has described the behaviour of *Perameles nasuta* in captivity, and observations have been made on *P. gunni* and *Isoodon obesulus* in Tasmania (Heinsohn, 1966). However, little biological data is available for the desert species. Of these apparently only *M. lagotis* has been maintained in captivity for any length of time and has been bred on a number of occasions (Watts, 1970; Hulbert, 1972). However, apart from the early observations of Jones (1924) and recent ones by Jenkins (1974), little has been published about the behaviour of this species.

These notes are based on observations of a group of four *M. lagotis* (3 females, 1 male) which were maintained at the Field Station of the Institute of Medical and Veterinary Science. The three females were wild-caught in the Warburton Ranges, W.A., and Papunya, N.T., while the one male was bred in captivity. They were caged together in an indoor pen measuring 6 x 3 x 1 m, maintained under 12 hour, reversed-cycle lighting. During the 'night' the pen was illuminated by infra-red lights, one of which was lowered to allow the animals to bask. The pen was floored with sand to a depth of approximately 50 cm, and contained large, hollow logs which served as refuges for the animals. The diet provided was similar to that listed by Collins (1973) for *M.lagotis* maintained at the Institute of Medical and Veterinary Science. Water was continuously available.

Unfortunately it was found that the one male suffered from weakness in his hind legs, which has been attributed to toxoplasmosis (Watts, 1970). For this reason this animal's locomotion and postures were abnormal, and these aspects of his behaviour were disregarded. His disability may also have made normal mating impossible.

At the time observations were made all the animals had been in captivity for several years, and took little notice of observers. The animals were watched at irregular intervals over a period of 2½ years.

NOTES ON BEHAVIOUR

1. Activity Rhythm

The animals were seldom observed active during the 'day' portion of the cycle, and usually retired to refuges within 5 mins when illumination was increased. During the 'night' each animal showed a number of active phases, usually of several hours' duration. There was little synchronization of activity except at feeding time, when all animals emerged.

2. Sensory Abilities

Although no specific tests were carried out, the impression was gained that the animals were strongly dependent on the senses of smell and hearing. Food was detected by smell rather than sight. The bandicoots frequently attended to sounds, but their vision was poor, particularly for objects more than a few metres distant.

3. Postures

Some common postures are shown in Fig. 1. These include:

(1) Indecision alert - the animal stood motionless with ears erect and one forepaw raised.

(2) Investigatory upright - the bandicoot lifted both forepaws and stretched upward, balancing on hind legs and tail.

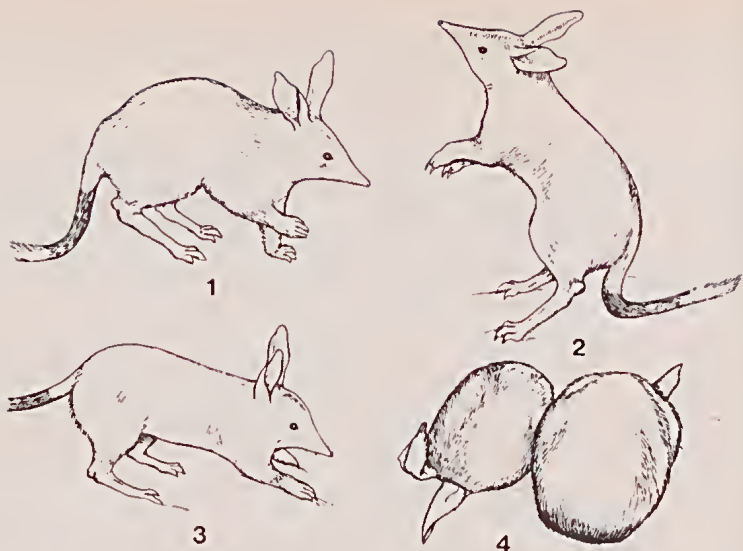(3) Digging crouch - the body was held low to the ground with both forelegs extended in front of the animal.

Figure 1. Some postures of *M. lagotis:* (1) Indecision alert, (2) investigatory upright, (3) digging crouch, (4) sleeping.

(4) Sleeping - two sleeping postures were observed, varying with ambient temperature. At low temperatures the position described by Wood Jones (1924), in which the head was tucked between the forelegs was adopted. At higher temperatures, particularly when basking, the bandicoot lay on its side with legs extended.

4. Locomotion

A series of still photographs arranged in sequence was used to examine the normal mode of locomotion. As can be seen from Fig. 1 the forelegs are moved alternately but the hind legs remain close together at all stages. This basic gait varied greatly in speed. When the bandicoot was foraging, a slow walk in which the hind legs were moved independently was sometimes observed.
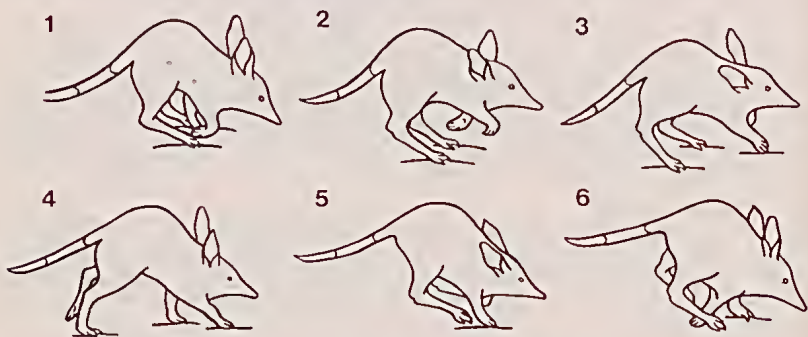

Figure 2. Successive positions in the "galloping" gait of *M. lagotis.* Drawn from photographs.

5. Feeding

In captivity *M. lagotis* accepted both animal and vegetable food. However, the bandicoots' foraging behaviour consisted of scraping small, conical pits in the sand using both forepaws, held together. These pits were then probed with the animal's long, sensitive nose. This foraging pattern resulted in the scratchings

characteristic of bandicoots generally. Such behaviour seemed to be directed towards locating insects, although bulbs and roots may also be located in this way. Prolonged digging and scratching followed the scattering of mealworms in the animals' pen.

When the bandicoots were offered food in dishes, they persisted in digging and scratching around the dishes, although this did not uncover anything edible. They also raked with their forepaws at cereal porridge contained in dishes.

Regurgitation of food, which was accompanied by rapid flickering of the animal's tongue, was observed on several occasions.

6. Grooming

Rabbit bandicoots have long, fine coats which require considerable maintenance. Three grooming methods were observed. One was the rodent-like pattern in which the bandicoot sat on its haunches and rubbed both forepaws simultaneously over either side of the snout. The use of this method was limited in *M. lagotis* by lack of flexibility in the forepaws and forelegs, and only the snout was cleaned in this way.

Secondly, the bandicoots frequently scratched and combed their fur with the syndactyl claw of the hind foot, licking the claw between scratches. A large area of the body surface was groomed in this way, excluding the hindquarters and the tail. Thirdly, the animal groomed by turning its head and nibbling or licking its fur directly.

Prolonged grooming sessions were not observed, possibly because these take place in refuges immediately after arousal. Most grooming consisted only of a brief treatment of one particular area of the body.

After eating cereal porridge, the animals often thrust their noses into the sand, thus coating the snout with soil.

7. Burrow Digging

True burrows could not be constructed under the captive conditions due to the shallowness of the sand. However, attempts at burrow digging were often made, and short burrows dug under logs in the pen.

When burrow digging the bandicoot scraped strongly at the sand with both forepaws, and when a pile of material had accumulated it was dispersed by a powerful, backward kick of the hind legs moved together. While digging, the bandicoot frequently paused and sat alert for a short period before resuming. No sign of cooperative digging was observed.

Burrow digging was a routine activity, but was also performed as an escape reaction after disturbance by humans or aggression from another animal. No nest-building behaviour was observed although suitable material was available.

8. Aggressive Behaviour

It was found early in the history of the colony (Watts, 1970) that groups of *M. lagotis* could be maintained in captivity without serious fighting occurring. In the present group, aggressive behaviour was seldom observed. Such fighting as did occur consisted of one animal directing loud threat hisses at another, which usually retreated immediately. If the second animal did not retreat, the two circled one another briefly, nose to tail, hissing loudly. On rare ocasions this was followed by one animal leaping at the other, attempting to bite its rump or flank. Such attacks only resulted in loss of fur, however. Displacement activity, in the form of the participants thrusting their noses into the sand, often followed aggressive interactions.

At feeding time the male frequently attempted to push the females away from the food dish, but there was no other evidence of any type of dominance hierarchy.

9. Amicable Behaviour.

The four bandicoots invariably shared one refuge when sleeping, but usually ignored one another when active. The male frequently sniffed the cloacal area of a nearby female, and females occasionally sniffed one another.

One attempted mating was observed in January, 1972. On this occasion the male persistently followed one female for several hours, and made many attempts to mount. During these attempts, he rested his head along the female's back and gripped her with his forelegs. The female attempted to

escape from him, and on several occasions fell on to her side while trying to dislodge him. This mating appeared incomplete, and no young resulted.

DISCUSSION

M. lagotis displays a number of behavioural characteristics which distinguish it from other bandicoots which have been studied in captivity. Unlike *P. nasuta, P. gunni* and *I. obesulus,* which dig only shallow depressions and shelter in surface nests, *M. lagotis* is an energetic burrower in captivity and uses both fore and hind legs in digging, as do truly fossorial mammals. Jenkins (1974) has mentioned the great difficulty that aborigines had in digging up rabbit bandicoots due to the speed of their burrowing. In the wild, *M. lagotis* constructs deep, spiral burrows, and each animal appears to use a number of burrows (Watts, 1969). No nests are constructed either in captivity or in the field.

Observations on food preferences of captive animals suggest that *M. lagotis* is omnivorous. In this respect it does not differ from other bandicoots studied. The foraging pattern shown by *M. lagotis* is very similar to that described for other species of bandicoots (Stodart, 1966; Heinsohn, 1966). In all species insect food is preferred to other types. Heinsohn has described predation on baby mice by *P. gunni* and *I. obesulus* in captivity. *M. lagotis* also ate mice (as noted by Jenkins, 1974), but the fact that the food was located by smell, combined with the poor vision and lack of manual dexterity, suggests that this species is ill-equipped to capture fast-moving prey.

Field study of the diet of *M. lagotis* confirms its omnivorous habits. Smyth and Philpott (1968) found that the diet of rabbit bandicoots in the Warburton Ranges, W.A., consisted mainly of termites, while Watts (1969) found that animals in several Northern Territory localities subsisted largely on seeds, bulbs and fungi.

In marked contrast to *I. obesulus,* which is a highly aggressive species (Wood Jones, 1924; Heinsohn, 1966) and often injures conspecifics, individual *M. lagotis* are tolerant of one another. Pairs of *P. gunni* and *P. nasuta* (Stodart, 1966) are compatible in captivity, but maintenance of groups of animals in small areas has usually led to aggressive behaviour. Therefore, it appears that *M. lagotis* is the least aggressive of all the bandicoots maintained in captivity. In addition, successful breeding has occurred among rabbit bandicoots kept in small areas (Watts, 1970; Hulbert, 1972).

The limited data available on the ecology of *M. lagotis* suggests that, although colonies are widely scattered, a male and female, together with their latest young, may share a single burrow (Krefft, cited in Troughton, 1967; Watts, 1969). If this is the case, the tolerance observed between adults in captivity may be reflected in their social behaviour in the wild.

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OBSERVATIONS ON THE POLLINATION BIOLOGY OF *NYMPHAEA GIGANTEA* W.J. HOOKER (NYMPHAEACEAE)

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On January 28 and 29, 1982, I was afforded a brief opportunity to observe a small population of *N. gigantea* growing in Lily Creek of Hidden Valley near Kununurra, Western Australia (lat. 15°46'S, long. 128°45'E). Although the pollination biology of *Nymphaea* has been the subject of recent studies (Meeuse and Schneider, 1980; Schneider and Chaney, 1981) no previous observations on the pollination biology of *N. gigantea* have been made except for those of Schmucker (1932 1933, 1935) which were conducted within a greenhouse. This species is singularly important since it is the only member of the subgenus *Anecphya*, a water lily group well-known to lack carpellary (and usually staminal) appendages (Conrad, 1905). This structural difference with other *Nymphaea* species is well illustrated in Aston (1973; fig. 52). Although the structure-function relationships of these appendages remain undetermined, it has been hypothesized that they play a role in the attraction and nutrition of beetle pollinators (Schneider, 1982) in nocturnal flowering *Nymphaea* species. In diurnal species, however, the carpellary appendages appear to be involved in increasing the size and/or depth of the central stigmatic pool, in which, on the first day of anthesis, pollinators lose their pollen loads and occasionally drown. A field study of the pollination biology of *N. gigantea* may thus further our understanding of the pollination syndromes and the adaptive radiation of the genus.

Flowers of this species undergo at least four consecutive days of blooming. Flowers are fully open by 9.30 a.m. and close by (ca.) 5.00 p.m. First-day flowers are about 20 cm above the water, inodorous and characterized by their dark purple-violet corolla which, together with the calyx, is positioned to form a funnel-shaped perianth. The stamens are nearly vertical or sloped inward, with the anthers nodding, apparently not well supported by the narrow filaments. At the bottom of the "funnel" is the cup-shaped gynoecium, filled with a stigmatic secretion (ca. 5 ml). Twice, I was fortunate to observe *Trigona* bees, each with a considerable amount of pollen in its corbiculae (pollen baskets), visit fluid-filled, first-day flowers. In one case a *Trigona*, while attempting to land on the innermost stamens, accidently landed in the stigmatic fluid. Once wetted most of the pollen was "washed" from the bee and precipitated to the stigmatic surface. In the other instance, another *Trigona* sp. attempted to land on an anther. The narrow filament of the stamen bent downward dropping the insect to a lower anther where this process was repeated. Ultimately, the small bee "slipped" into the stigmatic fluid with the same result as mentioned above (i.e. cross-pollination).

During the second and succeeding days of anthesis, flowers become further elevated to about 30 cm above the water surface and the corolla fades to a light purple-violet. These older flowers are functionally staminate, with the numerous anthers dehiscing large quantities of pollen. The stigmatic surface is dry (non-receptive) and covered by the innermost stamens.

In addition to the *Trigona* bees, several Galerucinae beetles (Chrysomelidae) and a single individual of both *Leioproctus (Anacolletes)* sp. (Apidae) and an ephydrid fly were observed actively foraging for pollen. Although the former two insects were observed visiting a first-day (pollen-receptive) flower, I did not witness either of the organisms to come in contact with the potentially dangerous stigmatic pool in the manner described for the *Trigona* bees.

This field study supports Schmucker's concept, deduced from greenhouse observations, of the pollination mechanism in *N. gigantea*. Overall the mechanism is similar to that described in other diurnal species of *Nymphaea*, in which solitary bees are the principal pollinators. These bees and other pollinators either land directly in the fluid or the anatomy-morphology of the flower is so constructed as to create a sliding or dropping effect into the